INTARG®
16 th International Invention and Innovation Show INTARG
24-25 May 2023
Katowice - POLAND

Non-toxic light-cured new generation dental fillings with low polymerization shrinkage

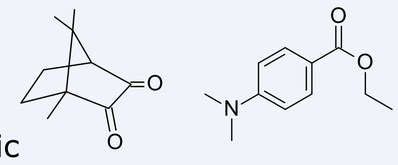
Monika Topa-Skwarczyńska[1,2], Małgorzata Tyszka-Czochara[3], Patrycja Środa[1], Weronika Wielgus[1], Joanna Ortyl[1,2,4]
[1]*Cracow University of Technology, Faculty of Chemical Engineering and Technology, Laboratory of Photochemistry and Optical Spectroscopy, Warszawska 24 St. 31-155 Cracow, Poland,*
[2]*Photo HiTech Ltd., Bobrzyńskiego 14, 30-348 Kraków, Poland*
[3]Jagiellonian University, Faculty of Pharmacy
Medyczna 9 St. 30-688 Cracow, Poland
[4]*Photo4Chem sp. z o.o.., Lea 114, 30-133 Kraków, Poland*
Contact: monika.topa@doktorant.pk.edu.pl, jortyl@pk.edu.pl

MOTIVATION

The invention relates to the development of **completely new initiating systems and resins** for the preparation of new-generation photo-curable dental composites, as well as the preparation of completely new dental composites with improved performance properties compared to dental fillings currently available on the market. Above all, the new dental composites are characterized by a lack of toxicity, due to the elimination of toxic aromatic amines used as co-initiators in commercial dental fillings. Scientific research shows that amines cause cytotoxic and genotoxic effects. Acrylate monomers, used as the organic matrix in standard dental fillings, which cause high polymerization shrinkage and are additionally allergenic, have also been eliminated. Polymerization shrinkage is very unfavorable, as it can cause the formation of stress-induced microcracks, poor adhesion of the photo-cured material to the substrate, delamination of the surface, deformation of shape symmetry. All this can lead to the formation of secondary defects and consequently to caries.

The invention developed safe, non-allergenic, universal, high-performance initiator systems dedicated to photopolymerization processes of various types for obtaining non-toxic dental fillings with low polymerization shrinkage.

Disadvantages of standard initiating system



- toxic
- lack of color stability
- CQ generates a yellow color

OUR APPROACH

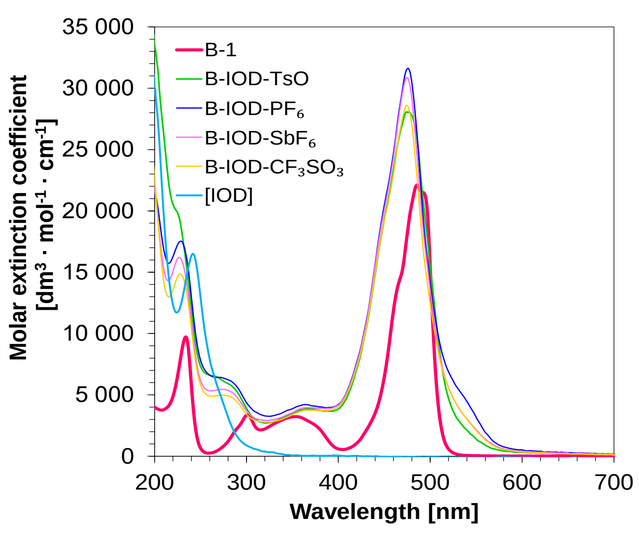
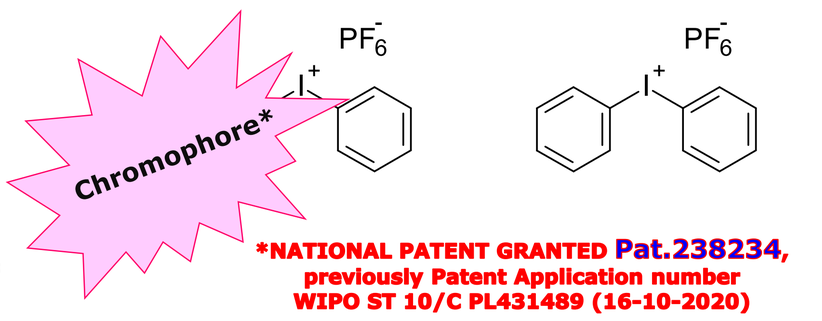


Fig. 1. UV-visible absorption spectra of the novel iodonium derivatives in acetonitrile.

Novel photoinitiators absorb up even to 600nm

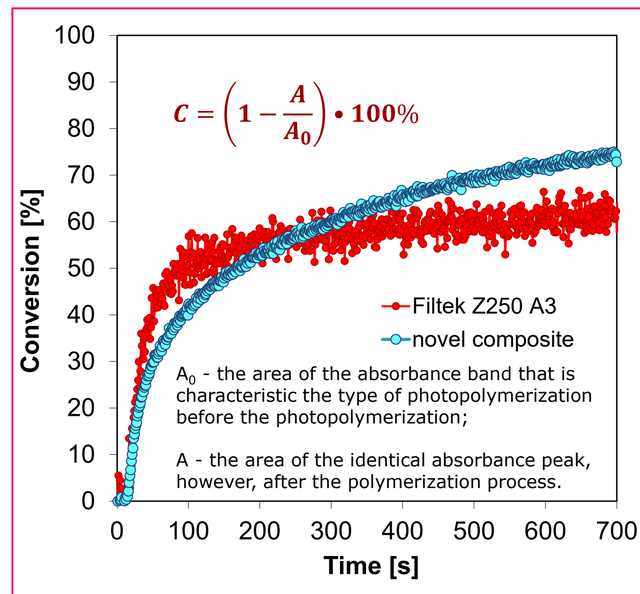
NOVEL photoinitiator based on iodonium derivatives

Commercial iodonium salt absorbs in the range up to only about 300 nm



***NATIONAL PATENT GRANTED Pat.238234, previously Patent Application number WIPO ST 10/C PL431489 (16-10-2020)**

PATENT APPLICATIONS P.441955, P.441956, P.441957 (07-08-2022)



The developed composites are characterized by high degrees of conversion

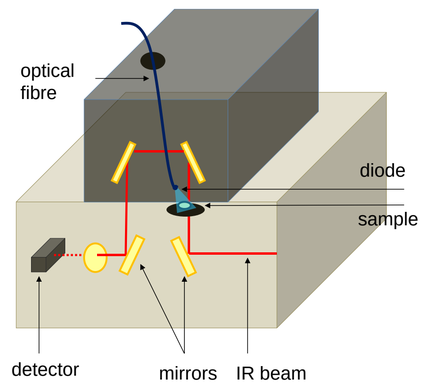


Fig. 2. Comparison of the kinetic profile of a newly developed composite with the profile of the commercial dental filling during the photopolymerization process under Vis-LED irradiation with an emission maximum at 405 nm and intensity of 200 mW/cm²
Diagram demonstrating the apparatus for measuring the Real-Time FT-IR conversion rate

Novel photoinitiators are useful for obtaining composites by cationic, radical and cationic-radical photopolymerization and do not generate yellow color

Novel initiators

cationic **cationic-radical** **radical**

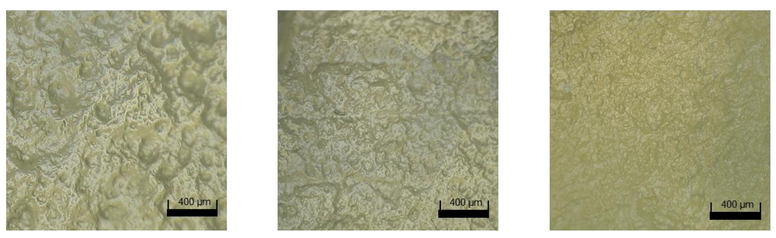


Fig.3. Structure and colour of the developed compositions observed under an Olympus microscope

Composites have low polymerization shrinkage

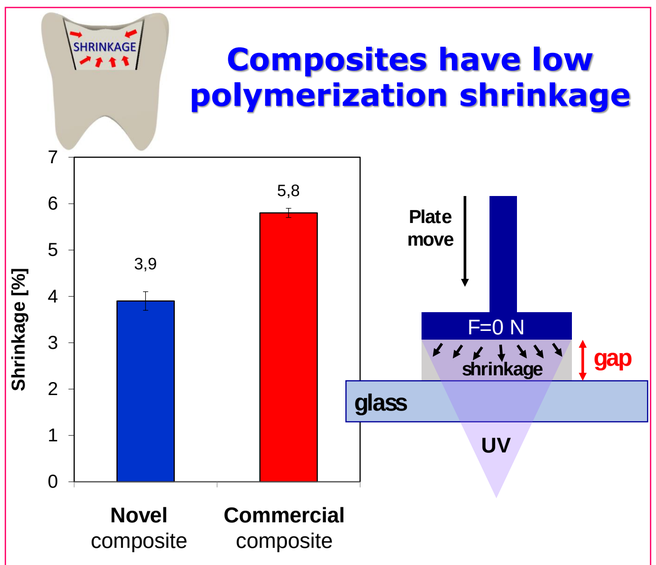


Fig. 4. Comparison of the final polymerization shrinkage of a new composite and a commercial composite determined from tests using the Anton Paar rheometer. Schematic demonstrating the shrinkage measurement process using the rheometer.

The developed composites are non-toxic

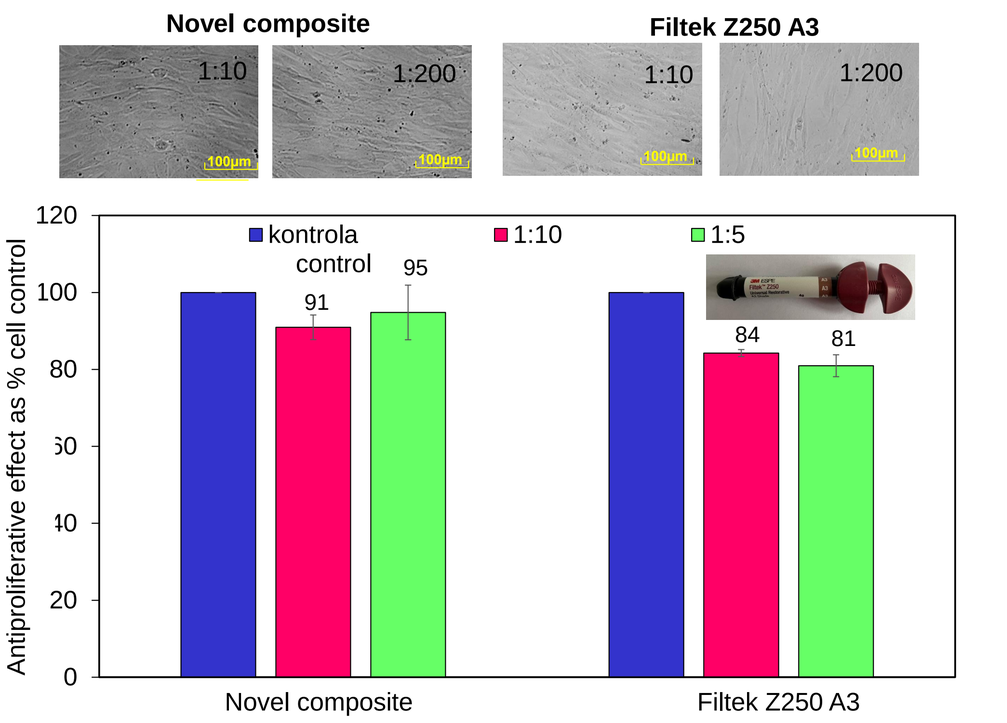
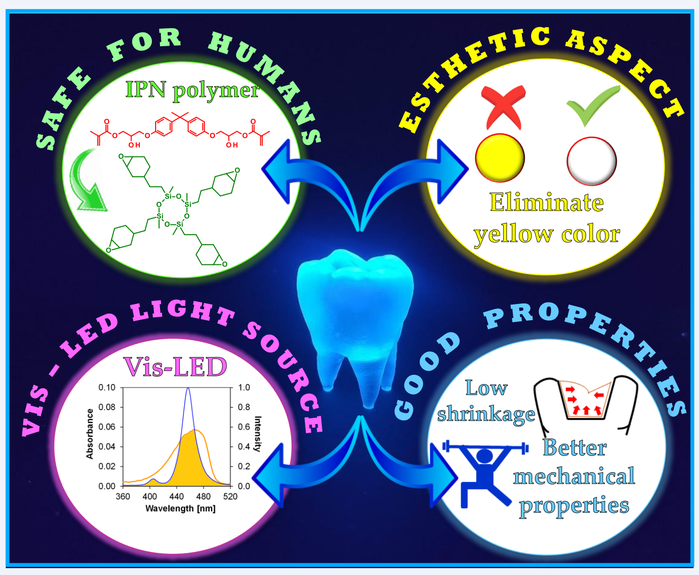


Fig. 5. Microphotographs of human BJ lineage fibroblast cells exposed to different compositions after curing obtained with an Olympus IX-70 microscope (top)
Percentage survival of human BJ lineage fibroblast cells depending on the type of composite

Fig. 6. Photographs demonstrating steps in the preparation of composites for cytotoxicity testing.

OUR NEW GENERATION DENTAL COMPOSITES

- They are **completely safe for humans** - elimination of cytotoxic amines
- **They do not generate yellow color** - elimination of camphorquinone, greater aesthetics and quality of the final product are preserved.
- Due to the use of polymerizable monomers according to the cationic mechanism, have a **reduced polymerization shrinkage**.
- For the curing process it is possible to use dental lamps emitting **radiation in the visible light range**, eliminating harmful UV radiation.



Monika Topa-Skwarczyńska is a PhD graduate student at the Faculty of Chemical Engineering and Technology, Cracow University of Technology (Poland) in prof. Joanna Ortyl research team.
To date, she has actively participated as the contractor in **7** research projects led by prof. Ortyl. Currently she is the manager of **3** projects: Diamond Grant-MNiSW, Prelude-NCN and commercial project TRL 4.0-MNiSW.

She is the co-author of **64** publications including **20** published in peer-reviewed journals from the JCR list and **5** patents and **3** patent applications. She has actively participated in **29** scientific conferences, Her research results have already been recognised both at the national and international arena. She has received nearly 40 awards for the presented results, which undoubtedly proves the innovation of her research. The most important are:

- ✓ **Finalist in the "25 under 25" competition in the Science category organised by Forbes magazine and McKinsey & Company office. 29.01.2020 Warsaw**
- ✓ Winner of the Shesnnovation Academy 2019/20, 06.10.2019
- ✓ Distinction in "Gold medal of chemistry 2017" 05.12.2017 Warsaw
- ✓ First place in the national competition "MŁODY WYNALAZCA 2017" 22.06.2017 Katowice

The work was funded by the National Science Centre (NCN, Poland), PRELUDIUM 17, project no: 2019/33/N/ST5/03015.
NATIONAL SCIENCE CENTRE POLAND